# REPORT DOCUMENTATION PAGE

*Form Approved*
*OMB No. 0704-0188*



| 1. REPORT DATE *(DD-MM-YYYY)* | 2. REPORT DATE | 3. DATES COVERED *(From - To)* |
|---|---|---|
| 13-11-2001 | Final Technical | April 2000 - February 2001 |

**4. TITLE AND SUBTITLE**
Motion Adaptation Syndrome: Gastrointestinal Aspects

**5a. CONTRACT NUMBER**

**5b. GRANT NUMBER**
N00014-00-1-0466

**5c. PROGRAM ELEMENT NUMBER**

**6. AUTHOR(S)**
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**5d. PROJECT NUMBER**

**5e. TASK NUMBER**

**5f. WORK UNIT NUMBER**

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**
The Pennsylvania State University
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**8. PERFORMING ORGANIZATION REPORT NUMBER**

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**
Office of Naval Research
Ballston Centre Tower One
800 North Quincy Street
Arlington, VA 22217-5660

**10. SPONSOR/MONITOR'S ACRONYM(S)**

**11. SPONSORING/MONITORING AGENCY REPORT NUMBER**

**12. DISTRIBUTION AVAILABILITY STATEMENT**
Approved for Public Release, distribution in Unlimited.

**13. SUPPLEMENTARY NOTES**
none

**14. ABSTRACT**
See attached page



**15. SUBJECT TERMS**
Motion Sickness, Nausea, Protein, Gastric Activity

| 16. SECURITY CLASSIFICATION OF: | | | 17. LIMITATION OF ABSTRACT | 18. NUMBER OF PAGES | 19a. NAME OF RESPONSIBLE PERSON |
|---|---|---|---|---|---|
| a. REPORT | b. ABSTRACT | c. THIS PAGE | | 8 | Robert M. Stern |
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14. Abstract

The purpose of this study was to determine what types of meals are most effective for preventing the development of gastric tachyarrhythmia and the symptoms of motion sickness provoked by a rotating optokinetic drum. 18 participants were exposed to the rotating drum three times. Participants received either a carbohydrate beverage (lemonade), a protein beverage (chocolate protein shake), or nothing immediately before exposure to the rotating drum. Electrogastrograms (EGGs) and subjective symptoms of motion sickness (SSMS) were collected during a 6 min baseline period and a subsequent 16 min drum rotation period. The change in percent gastric tachyarrhythmia from baseline to drum rotation was significantly different across conditions, $F(2,34)=3.46$, $p<.05$. Gastric tachyarrhythmia increased significantly less in the carbohydrate condition than in the no meal condition ($p<.05$), and significantly less in the protein condition than in the no meal condition ($p<.10$). SSMS scores were significantly lower in the protein condition than in the carbohydrate condition ($p=.06$), and also significantly lower than in the no meal condition ($p<.01$). In conclusion, liquid protein meals were most effective for suppressing both the development of gastric tachyarrhythmia and symptoms of motion sickness.

# FINAL REPORT

GRANT TITLE: Motion Adaptation Syndrome -- Gastrointestinal Aspects

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INSTITUTION: The Pennsylvania State University

GRANT NUMBER: N00140010466

AWARD PERIOD: April 1, 2000-Dec. 31, 2000 (no-cost extension to Feb. 28, 2001)

OBJECTIVE: Past studies have shown a relationship between gastric myoelectrical activity and motion adaptation syndrome (MAS) susceptibility. The purpose of the proposed research was to observe if the manipulation of gastric myoelectrical activity with selective foods would reduce MAS susceptibility.

APPROACH: This research utilized a controlled experimental design with human subjects. Subjects consumed one of several different types of meals known to cause an increase in normal gastric myoelectrical activity and a decrease in gastric myoelectrical activity associated with MAS. Subjects were then exposed to a provocative motion environment. The experience of MAS was measured using a variety of questionnaires and physiological measures.

ACCOMPLISHMENTS: Two studies were completed prior to the sudden termination of funding. The first study examined the effects of a liquid protein meal and a liquid carbohydrate meal on MAS vs. no meal. The results indicated that a liquid protein meal was superior to a liquid carbohydrate meal or no meal at all in reducing MAS (see Attachment 1). The second study examined the role of time since eating on MAS. It was found that drinking a liquid protein meal immediately prior to or 1 hour prior to exposure to provocative motion were both equally effective in minimizing MAS.

SIGNIFICANCE: The goal of the research was to develop a behaviorally based gastric countermeasure for MAS for use in operational environments where more aggressive pharmaceutical treatments are not feasible. This will contribute significantly to the long search for a side-effect-free treatment for MAS. The culmination of the research up to this point has led to the following conclusion: a liquid protein meal when ingested between 0-60 minutes prior to exposure to a provocative motion environment leads to some protection against MAS.

This research supports a major priority, "we need to prevent casualties", of the Warfighter Protection Future Naval Capability. MAS places warfighters at risk by decreasing situational awareness and mission effectiveness. As part of this priority, one of the goals by FY 2007 is enhanced maintenance of spatial orientation. Spatial orientation is a sub-set of situational awareness. Reducing MAS by regulating stomach activity through food, could lead to the maintenance of a higher level of situational awareness and help combat spatial disorientation. In my opinion, continued funding of this program of research would lead to an optimum meal regimen for combating MAS.

SUGGESTIONS FOR FUTURE RESEARCH: There are several issues that need to be addressed. First, the use of solid carbohydrate and protein meals need to be investigated as only liquid meals have been investigated up to this point. Solid meals might be more convenient for deployed personnel because they could simply carry several protein or carbohydrate bars with them. Solid meals need to be investigated both for efficacy and for timing of ingestion. Solid meals are digested differently from liquid meals, so the time course may be different. Second, the most effective meals must be further tested using a vestibular stimulus. Deployed environments include ship and flight motion, both of which involve stimulation to the vestibular system and visual system, not the visual system alone. Hence, the objectives of follow up research should be to examine solid meals and vestibular stimuli.

**PUBLICATIONS, ABSTRACTS, TECHNICAL REPORTS, PATENTS, AND AWARDS:**

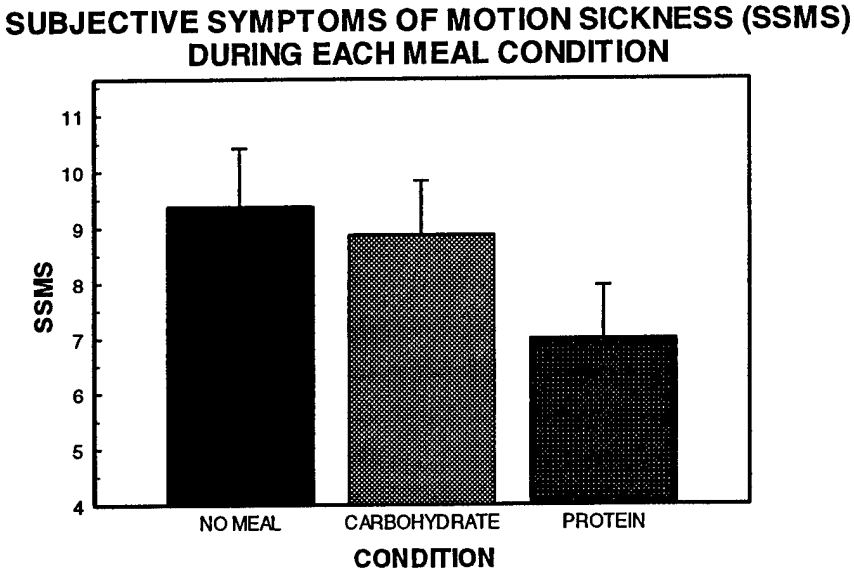
1. **Levine ME, Williamson MJ, Muth ER and Stern R (2001). The effect of liquid carbohydrate and protein meals on gastric tachyarrhythmia and susceptibility to vection-induced motion sickness. Gastroenterology, 120, A716**

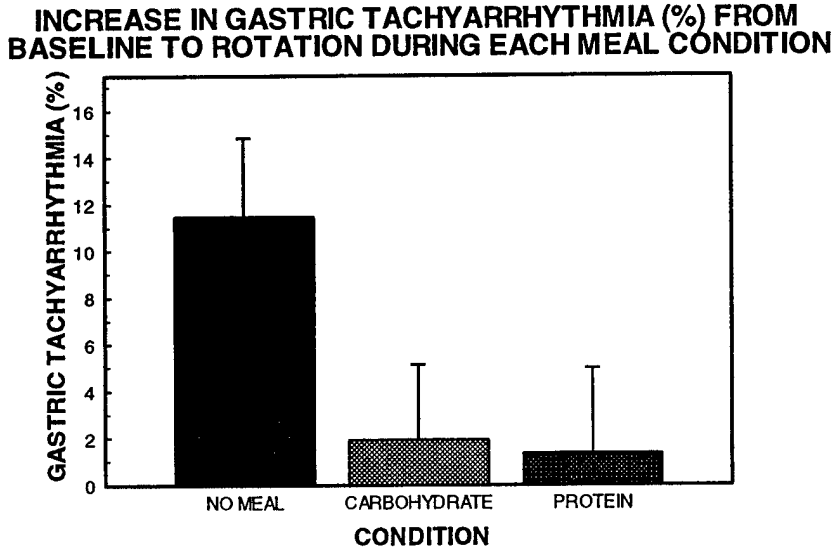
2. **Max Levine won the Walter Alvarez Award for research in Electrogastrography at the ninth annual meeting of the International Electrogastrography Society for his presentation on The Effect of Liquid Carbohydrate and Protein Meals on Gastric Tachyarrhythmia and Susceptibility to Vection-Induced Motion Sickness.**

**POTENTIAL PATENTABLE INVENTIONS: None**

## ATTACHMENT 1 – STUDY RESULTS

**The first figure below illustrates that the lowest symptoms of motion sickness were experienced when a protein meal was ingested immediately prior to exposure to a provocative motion environment. The second figure below illustrates that both meals reduced the amount of tachyarrhythmia, a stomach dysrhythmia associated with nausea, experienced during provocative motion when compared with no meal. Examining both figures together illustrates that the protein meal was most effective in reducing tachyarrhythmia AND preventing symptoms of motion sickness during provocative motion exposure.**



ATTACHMENT 2—PUBLISHED ABSTRACT

# THE EFFECT OF LIQUID CARBOHYDRATE AND PROTEIN MEALS ON GASTRIC TACHYARRHYTHMIA AND SUSCEPTIBILITY TO VECTION-INDUCED MOTION SICKNESS

**Max E. Levine, Manda J. Williamson, Eric R. Muth and Robert M. Stern.**
**Departments of Psychology, The Pennsylvania State University and Clemson University**

**Background: The ingestion of a meal often reduces susceptibility to the development of gastric tachyarrhythmia, the abnormal activity of the stomach that frequently accompanies nausea. The purpose of this study was to determine what types of meals are most effective for preventing the development of gastric tachyarrhythmia and the symptoms of motion sickness provoked by a rotating optokinetic drum. Method: A repeated measures, counterbalanced design was employed in which 18 participants were exposed to the rotating drum three times with intersession intervals of at least two weeks. Participants received either a carbohydrate beverage (lemonade), a protein beverage (chocolate protein shake), or nothing immediately before exposure to the rotating drum. Electrogastrograms (EGGs) and subjective symptoms of motion sickness (SSMS) were collected during a 6 min baseline period and a subsequent 16 min drum rotation period. Results: The change in percent gastric tachyarrhythmia from baseline to drum rotation was significantly different across conditions, $F(2, 34)=3.46$, $p<.05$. Follow-up pairwise comparisons indicated that gastric tachyarrhythmia increased significantly less in the carbohydrate condition than in the no meal condition ($p<.05$), and significantly less in the protein condition than in the no meal condition ($p<.10$). Gastric tachyarrhythmia was not different between the two meal conditions. The difference in SSMS scores across conditions was marginally significant, $F(2,34)=2.52$, $p<.10$. Pairwise comparisons indicated that SSMS scores were significantly lower in the protein condition than in the carbohydrate condition ($p=.06$), and also significantly lower than in the no meal condition ($p<.01$). SSMS scores were not significantly different between the carbohydrate and no meal conditions. Conclusions: Liquid protein meals were most effective for suppressing both the development of gastric tachyarrhythmia and symptoms of motion sickness. Carbohydrate meals were also effective for maintaining normal gastric activity during exposure to**

**provocative motion, but were not helpful for reducing the subjective severity of nausea and motion sickness.**